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QUARTERLY REPORT

GTI PROJECT NUMBER 21874

Characterization and Fitness for Service of Corroded Cast Iron Pipe

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Project Objective

Gas Technology Institute's (GTI) objective in this project is to

- Provide a Fitness-For-Service (FFS) model and method for operators to characterize and grade graphitic corrosion defects on cast iron natural gas pipes. This will help operators make monitoring, repair, and replacement decisions, as well as prioritize accelerated replacement decisions related to cast iron mains and services.
- Summarize and categorize the required input parameters to the FFS model related to cast iron material, graphitic corrosion geometry and characteristics, and operational environment.
- Validate the FFS model by comparing its output to a statistically analyzed set of historical cast iron failure data.
- Provide a physical testing program to fully validate the FFS model.

Executive Summary

During this quarter, efforts were focused Task 4. Last quarter we completed the FEA Design Document which summarizes the finite element analysis (FEA) approach taken for this project. This quarter the actual FEA has commenced. In Task 5 we continued to collect references and data to help operators characterize graphitic corrosion in the field in a manner that will allow input to the fitness for service model.

Work Completed this Quarter (7/1/16 – 9/30/16)

Work Completed

Task 3. Historical Cast Iron Failures Statistical Analysis –Review of cast iron reported incidents and characteristics is still in progress.

Task 4. Finite Element Analysis of Failure Modes – Finite element analysis (FEA) has commenced and is following a design-of-experiment (DoE) matrix of 172 analyses.

Task 5. Characterize Graphitic Corrosion Severity - We are continuing to collect references and data to characterize graphitic corrosion in the field in a manner that will allow input to the fitness for service model.

Technical Status

Activity: Task 3 - Historical Cast Iron Failures Statistical Analysis

The interim report of Task 3 was due in the 3rd quarter of 2016 however GTI has requested an extension to 11/30/16.

Activity: Task 4 - Finite Element Analysis of Failure Modes

Finite element analysis (FEA) has commenced and is following a design-of-experiment (DoE) matrix of 172 analyses. If needed, additional analyses will be conducted to augment or expand the response surface from the initial analyses. The DoE matrix has the following parameters:

Table 1. DoE Parameter Table

Variable	Low	Mid	High
OD	6”	8”	12”
Flaw depth, % of wall thickness	10%	45%	80%
Flaw length, % of circumference	5%	25%	50%
Flaw width, fraction of flaw length	0.25	0.5	0.75
Flaw angle	0°	45°	90°

Pressure	0 psig	25 psig
Soil pressure	0 psig	100 psig
Axial restraint	No	Yes
Material	Class 40	Class 150

For the DoE analyses, a modification of the geometric modeling of corrosion wall loss was implemented, as shown in Figure 1 through Figure 3. In this modification, the (rectangular) profile of the material loss is swept along a helix, such that material loss depth follows the outer diameter of the pipe.

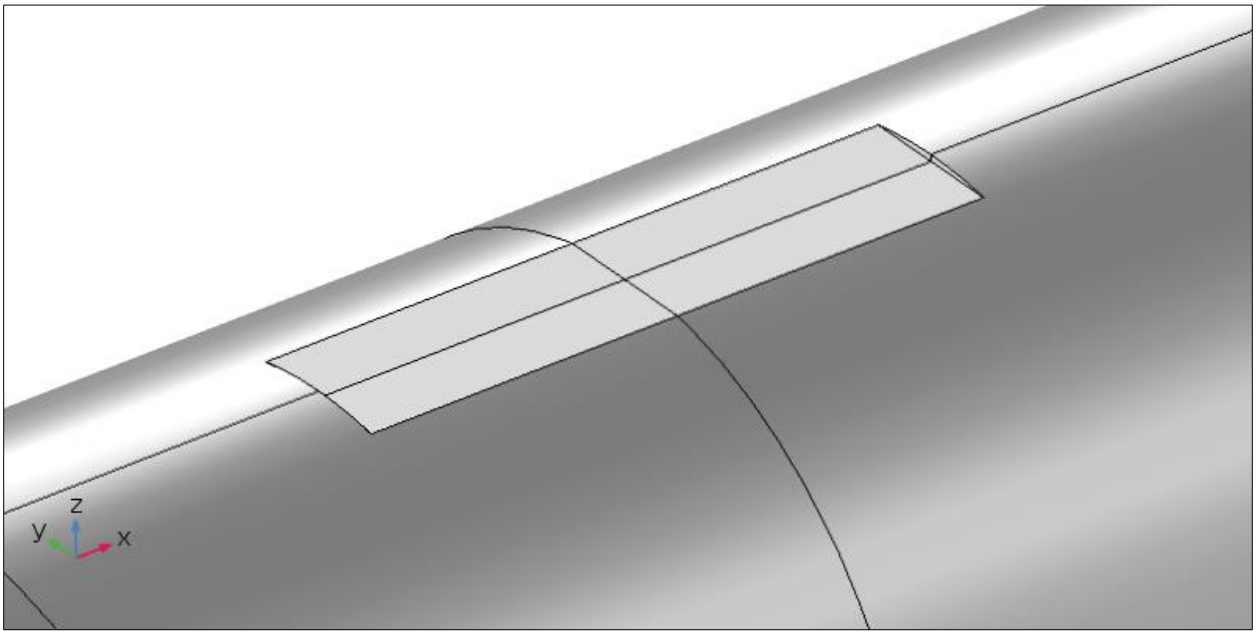

Figure 1. Axial flaw geometry using helical sweep

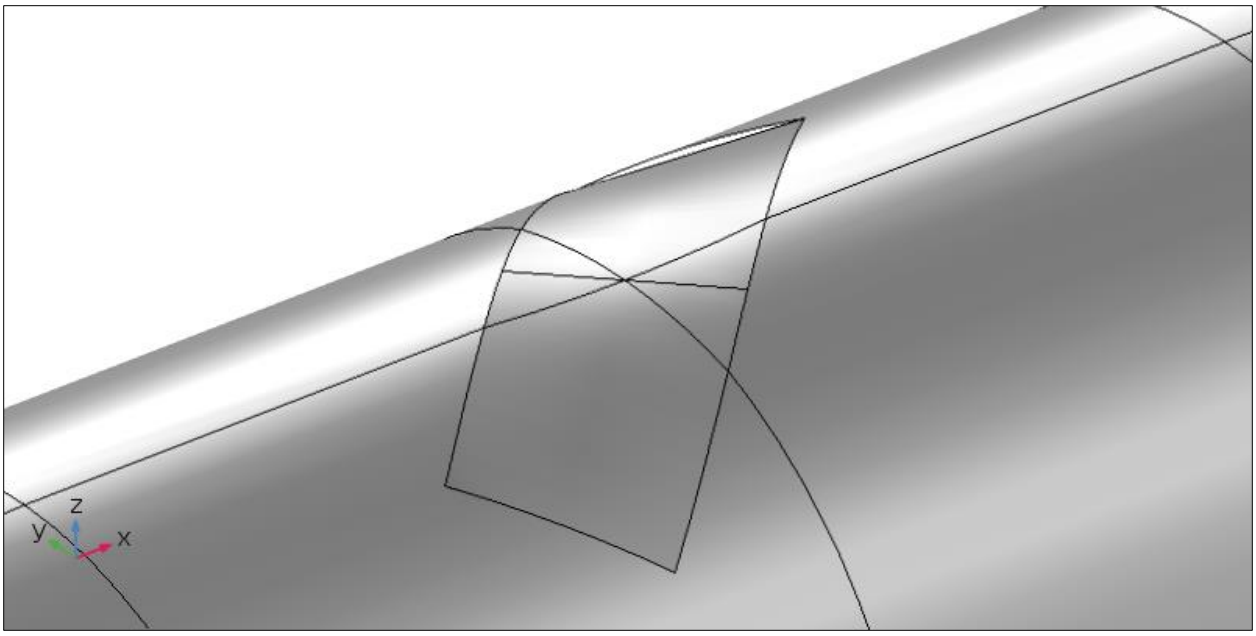

Figure 2. 45° rotated flaw geometry using helical sweep

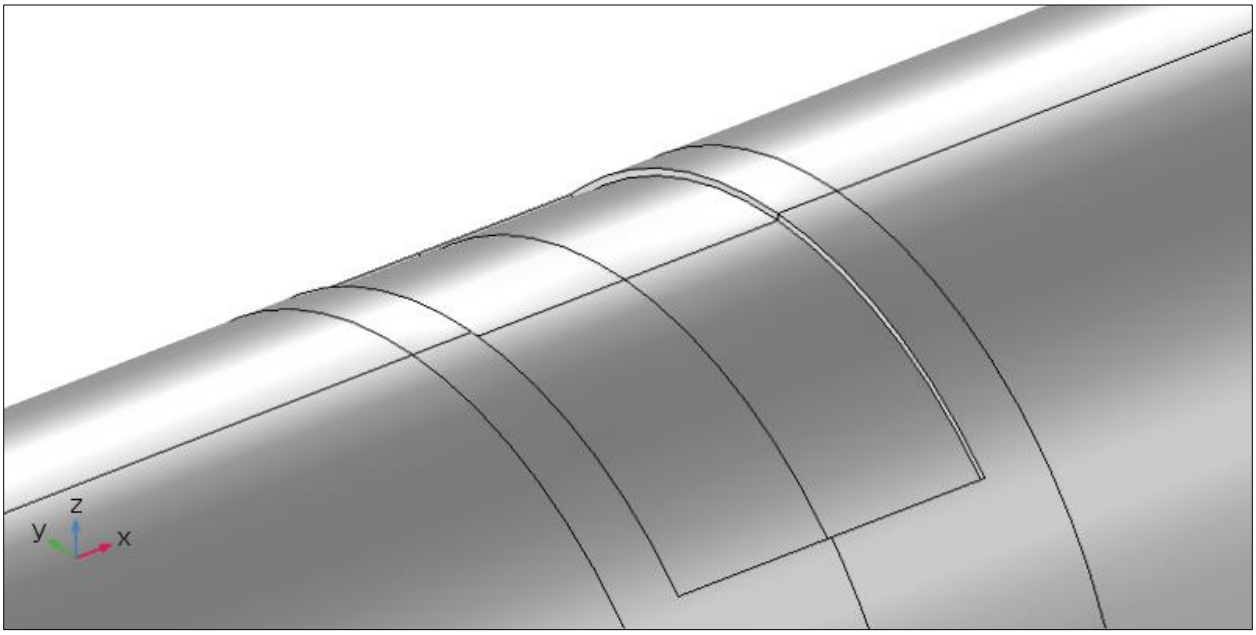

Figure 3. Transverse flaw geometry using helical sweep

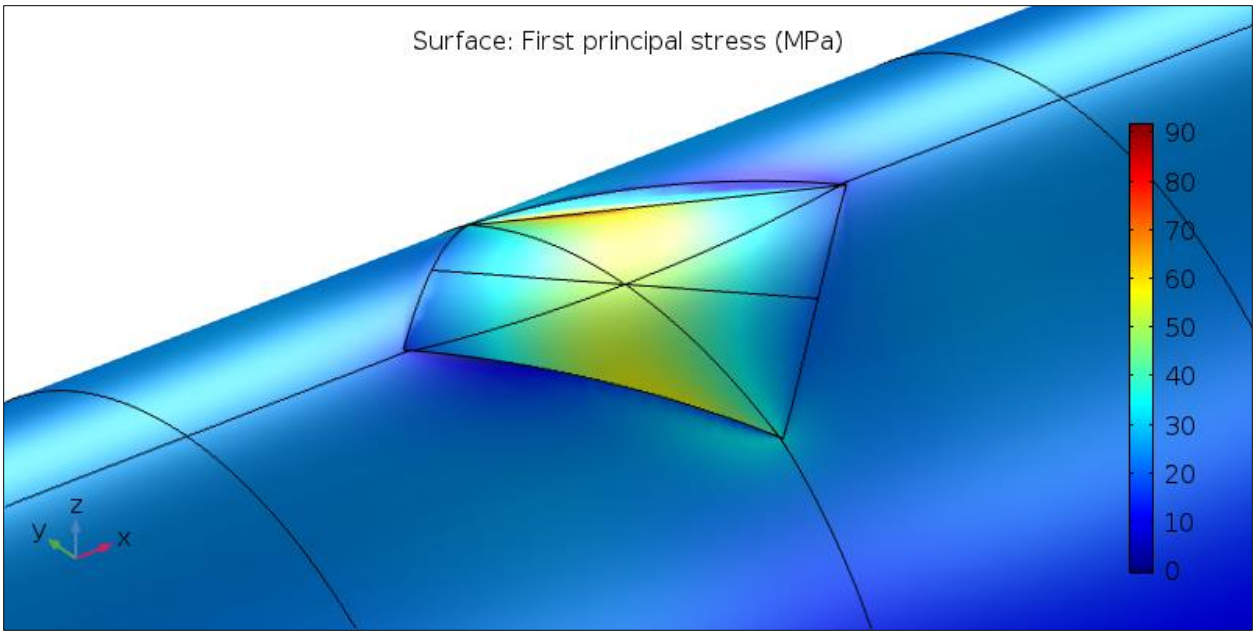

Figure 4. Example stress plot 45° rotated flaw geometry using helical sweep

Activity: Task 5 - Characterize Graphitic Corrosion Severity

We continued to collect references and data to help operators characterize graphitic corrosion in the field in a manner that will allow input to the fitness for service model.

Plans for Future Activity (Project Quarter #4)

The planned activities for the 4th Project Quarter are:

- Continue Task 3 work on Historical Cast Iron Failures and Statistical Analysis.
- Continue Task 4 Finite Element Analysis of Failure Modes
- Continue Task 5 Characterize Graphitic Corrosion Severity
- Submit monthly reports